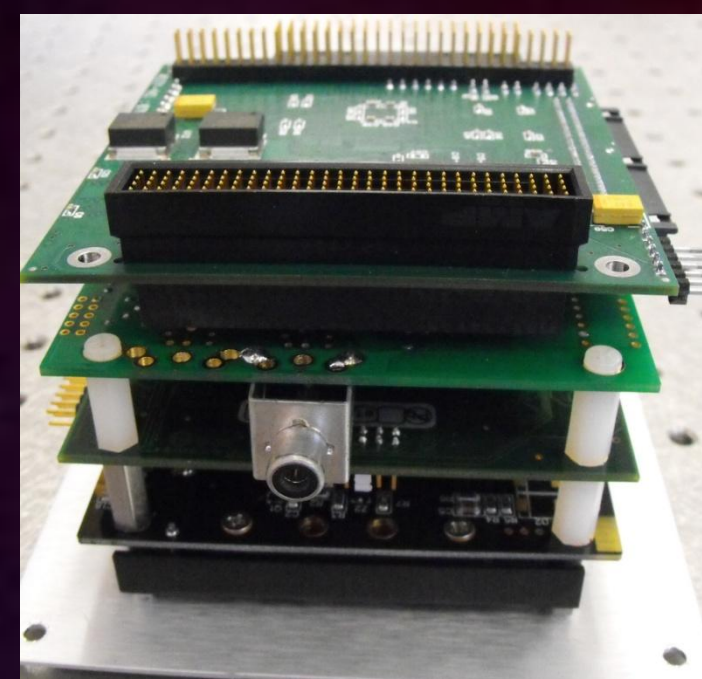


Softcore-Enabled Reconfigurable Computing



Abstract

The Softcore-Enabled Reconfigurable Computing (SERC) team is attempting to prove the concept of reconfigurability through a three part demonstration. The hardware we are using as our base reconfigurable computing board for all of the demos is a PC/104 board containing a Xilinx Virtex-II Pro. The Virtex-2 will implement a soft core processor, Microblaze, with extensions that allow a more complete use of the PC/104 architecture. In the first part of the demonstration, the reconfigurable stack uses the I-Robot Create to navigate a given area and find a black square using a small video camera. In the second part, the stack reads three scales and controls two pumps to precisely mix liquids. Finally, in the third part, the stack reads a photosensor and reports the results to a simulated mission computer.



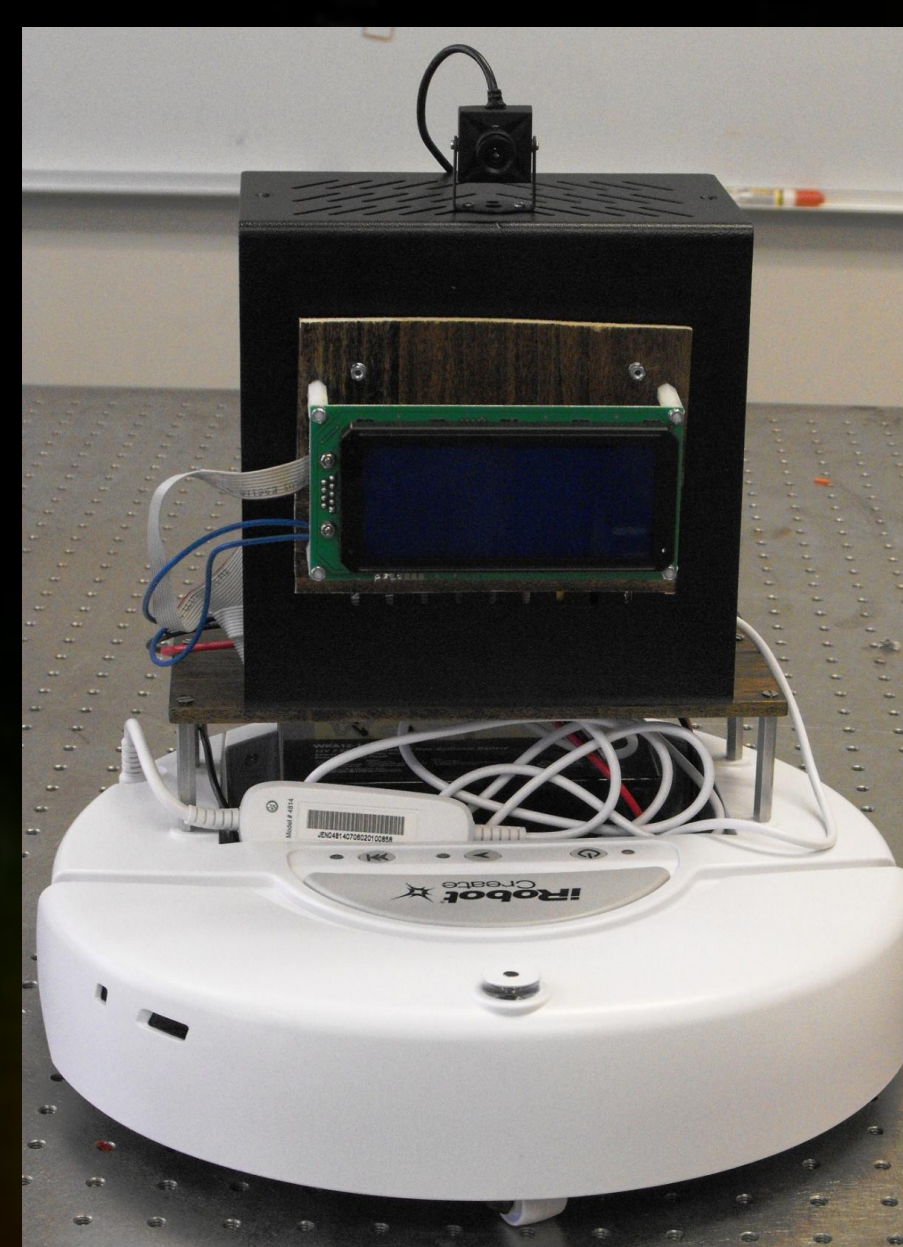
Purpose

Our team is working as part of a Radiation-Hardened Electronics for Space Environments (RHESE) / Reconfigurable Computing project. The overall goal of reconfigurable computing is to develop computing hardware to be used and reused in multiple mission areas. For example, astronauts are on the moon and the ascent stage of the Lunar Lander doesn't work. They could—with reconfigurable computing devices in place—remove the RC board from a spectrograph or some other completed experiment and reprogram it. They could then place it in the Lander and complete the mission. This also reduces the total number of spares they must bring with them since all parts will draw from a common pool of spares.

Part 1 – Robot Control and Image Processing

The PC/104 stack and set-up (right) consist of:

- Virtex-II Pro FPGA
- Pixelsmart512-8 Framegrabber Card
- Camera
- I-Robot Create



Operation:

- Navigate an NxM dimension pen and determine its size.
- Find the center of the pen.
- Once at center, rotate 360° and image walls
- If randomly placed square is found, drive to it, play happy song
- If square not found, play sad song

Function:

- Demonstrates that an FPGA with a Microblaze can:
 - Autonomously pilot a craft
 - Perform Image analysis

Part 2 – Controls



The PC/104 stack and set-up (above) consist of:

- Virtex-II Pro FPGA
- R104 Relay Board
- Laboratory Scales
- Fuel Pumps

Operation:

- Read mass of liquids on scales 1 and 2
- Mix liquids at specified ratio into center flask
- Adjust for error

Function:

- Demonstrates the ability to perform closed loop control

Part 3 – Fault Detection

The PC/104 stack and set-up (bottom) consist of :

- Virtex-II Pro FPGA
- A/D Converter Board
- Garage door sensors

Operation:

- Read analog value of receiving sensor
- Convert to digital value
- Send to Fault Detection Diagnostic and Response Simulator

Function:

- Integrates the FPGA board into a simulated mission.

